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GREENHOUSE GAS EMISSIONS AND HEALTH OUTCOMES IN NIGERIA

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ABSTRACT: *This study examined the impact of greenhouse gas emissions on health outcomes in Nigeria covering the period 1990-2021. Data for the study were extracted from the Central Bank of Nigeria (CBN) statistical bulletin and the World Development Index (WDI) 2021. The data are health outcome (life expectancy, greenhouse gas emissions, population and inflation rate). The method of data analysis used is the linear regression with the application of the Vector Error Correction Model (VECM) and the Granger causality statistics. The major findings of the study reveal that Greenhouse gas emissions negatively impact health outcomes in Nigeria and there is a uni-directional granger causality between greenhouse gas emissions and health outcomes in Nigeria. It is therefore the recommendation of the study that more resources should be channeled for research aimed at developing alternatives to greenhouse gas emissions and there is need to carry out a massive reform in our health sector. This reform should include setting up a special committee that ensures any allocated fund to the health-sector is adequately utilized.*

KEYWORDS: Greenhouse, Gas Emissions, Health Outcomes, Life Expectancy, Nigeria

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INTRODUCTION

The world is dominated by ever-increasing production demands that leave traces in the environment. The other side of this coin is the degradation of the environment in connection with the production of greenhouse gas (GHG) emissions, climate change, loss of the protective ozone layer, and global warming, which affect humanity, including its health (Manisalidis, 2020). According to a report published by the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change, 2014), humanity has warmed the planet over the past 50 years. Meanwhile, GHG emissions are considered a serious aspect of human activity contributing to this threatening state. These activities include burning fossil fuels, deforestation or intensive agriculture, and others. Thus, it is important to pay increased attention to emissions that enter the atmosphere, which include countless toxic substances.

Focusing on GHG emissions, the greatest consequences of global climate change with an impact on human health are represented by increased temperatures, the longer duration of temperatures, and their intensity. The heat also causes the occurrence of new pollen allergens and several premature deaths due to overheating of the body. In addition, more frequent forest fires caused by drought increase the cases of severe burns. All these facts indicate that there is no doubt that climate change is a current and future risk factor for health (McMichael, Woodruff, & Hales 2006). In fact, GHG emissions reduce the health potential of a population, which can be seen in the losses expressed by disability-adjusted life years (Eckelman, Gregory and Samuel, 2020).

The importance of health cannot be underestimated since it is a very important aspect of an individual's well-being and a nation's economy, as it is often said that "a healthy nation is a wealthy nation". Health can be defined as the fitness of a total physical condition, that is, the fitness of the body or mind, especially in the absence of illness, injuries, or impairments. The issue of good health condition is very important because it deals with not just humans but with the human body. Without a good health condition, it is almost impossible, if not totally impossible, to carry out any meaningful economic activity. Thus, good health is vital to the growth of any nation (Matthew, Anderson and Davidson, 2015). Nigeria faces the dual challenge of reducing GHG emissions while improving its citizens' general well-being.

Greenhouse Gases (GHG) emissions pose a high threat to our climate system, as argued in various literature. The global warming of 2.5^{o}C as obtainable, is said to be caused by Greenhouse Gases Emissions sourced from economic activities geared towards economic growth. However, the scientific and social science literature is saturated with the effect of GHG emissions on macroeconomic variables like economic growth, economic development, energy consumption, populations, government expenditure, etc. Obviously, there is a paucity of studies on the impact of GHG emissions on health outcomes in a developing country like Nigeria. Mathew, Kingsley and Klein (2018) attempted to carry out an empirical study on the effect of GHG emissions on health outcomes in Nigeria. The study lacked currency and was characterised by some other methodological issues, like making use of ARDL even when the variables are all integrated at order one. Therefore, This study is motivated to estimate GHG emissions' impact on health outcomes in Nigeria as literature has already established a link between them.

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LITERATURE REVIEW

Conceptual Review

Greenhouse Gas Emissions

Greenhouse gases (GHGs) are defined as gases capable of infrared absorption leading to the atmospheric trapping of heat (Oguwuike, Anyanwu and Jideofor 2019). These gases directly increase atmospheric heat and are greatly responsible for the greenhouse effect, which results in global warming. The causes of the greenhouse effect can be directly attributed to natural or biogeographical processes (such as the respiration of living plants and animals) as well as anthropogenic processes or activities such as fossil fuel use, deforestation, synthetic fertiliser use, intensive farming, and many industrial processes. Other causes are largely extraterrestrial factors such as solar radiation quantity (sunspot), solar radiation quality (ultraviolet radiation change), volcanic eruption, and meteor. However, the largest source of GHGs emission from anthropogenic processes or activities is from burning fossil fuels for electricity, heat, and transportation (Intergovernmental Panel on Climate Change, 2001). Another notable contributor is debris burning by subsistent and commercial farmers.

GHGs can intercept radiation and radiate it back to the earth's surface at different wavelengths. These GHGs are also responsible for regulating temperature on the earth's surface. There majorly exists five forcing GHGs (Carbon (IV)Oxide, Methane, Nitrous Oxide, Water vapour and Fluorinated gases) (Gray, 1990), all of which have natural and anthropogenic sources of emission. Still, anthropogenic sources outweigh natural sources in terms of emissions (Intergovernmental Panel on Climate Change, 2017). The mean warming effect of GHGs is about 33°C (590F) (Intergovernmental Panel on Climate Change, 2016).

The greenhouse effect describes the process of absorption and emission of radiation from infrared rays by gases in the atmosphere leading to increasing levels of warmth in the atmosphere and on the Earth's surface (Odigure, 2016). Stated simply, it is basically maintaining the temperature of surface air by atmospheric components by absorbing radiation and inhibiting the escape of same in similitude to a glassed roof and greenhouse walls. However, scientists first used the phrase (Greenhouse effect) early in the 19th century but were used to refer to natural occurrences related to atmospheric trace gases without any inclination towards a negative implication.

The concentration of GHGs in the atmosphere directly influences the greenhouse effect as increasing concentration increases the earth's insulation ability (Shires et al., 2019). Water vapour contributes between 36 and 70% to the greenhouse effect (excluding clouds); Carbon (IV) Oxide causes about 9–26%, attributed to Methane is 4–9%, while Ozone causes about 3–7% greenhouse effect (Gogoi and Baruoh, 2012). Other gases, such as Nitrous oxide (N2O), contribute less significant fractions to the greenhouse effect. The concentration of N2O increases as a result of agricultural or farming practices.

Greenhouse Gas Emissions and Human Health Implications

The adverse effects of gas emissions on humans are quite all-encompassing (NPI, 2016). Specifically, the pollutants have known adverse effects on human health, especially children, who are the most susceptible age group due to their peculiarities. Ozone, sulphur dioxide, and nitrogen dioxide gaseous substances can cause an increase in respiratory tract illness, asthma

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attacks and a reduction in the functioning of the lung. In some communities, breathing and circulation hospitalisations, cardiac death and even cancer of the lung are attributed to unpleasant repercussions of air pollution (Oguntoke and Adeyemi, 2017). When the level of concentration of nitrogen dioxide (NO2) is high, it can cause serious lung damage, which results in shortness of breath and chest pain (Oguntoke and Adeyemi, 2017).

Methane as an asphyxiant is known to displace oxygen, and when the displacement is 18%, asphyxia can result in exposed persons (Oguntoke and Adeyemi, 2017). In the case of H2S, short-term contact with a high level of concentration may cause respiratory tract ailments. The aftermath effect after a long while may result in undue tiredness, appetite loss, pain, tetchiness, loss of memory, faintness and women miscarriages (Oguntoke and Adeyemi, 2017). Too much contact with high levels of concentration (say about 10–50 ppb) of SO2 causes respiratory tract ailments (NPI, 2016).

Greenhouse Gas Emissions and Climate Change

Levels of GHGE in the atmosphere (which includes carbon dioxide (CO2) levels have been associated with an increase in climate change, and hence experts have suggested lately how to tackle climate change, which has to do with gradual reducing emissions of GHG; for instance, committing to the reduction of gaseous emission to 5% below 1990 points under the Kyoto Protocol (UNDP, 2018). The United Nations Structure Resolution on climatic change categorises response to climatic changes into main folds: firstly, the mitigation of climate change by plummeting emissions of GHG and attractive sinks; secondly, by adjusting the effect of climate change on health. Many of the developed nations devoted themselves to being a part of the UNFCCC and the Kyoto Protocol. These countries went ahead to adopt national policies and took equivalent measures to alleviate climate change and reduce their overall GHGE (Klein et al., 2017).

Theoretical Review

The Environmental Kuznets Theory (EKT)

The environmental Kuznet theory was propounded by Simon Kuznet in 1971. Simon Kuznets described the relationship between per capita income and income inequality as an inverted U or what later became known as the Kuznets curve (for which he won the Nobel Prize in 1971). The EKT shows the relationship between per capita income and environmental degradation. That is, as income rises, the degradation of the environment increases. However, once a threshold in income is reached, the degradation begins to subside. The EKT contradicted the widely held notion that wealthy nations damage their environment more quickly than poorer nations. It was believed that wealthy countries, in producing and consuming vast quantities of goods and services, used natural resources at a much greater rate and would subsequently damage their environment at a faster pace. The EKT suggests this is not the case. Poorer nations are believed to have cleaner environments simply due to lower consumption levels. However, there is another reason. Poorer nations tend to lack industrialisation.

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Health Belief Model

The Health Belief Model (HBM) was developed by Irwin Rosenstock in 1966 and has been identified as one of the earliest and most influential models in health promotion. It was inspired by a study of reasons people expressed for seeking or declining X-ray examinations for tuberculosis caused by emissions in the environment. Initially, the model included four constructs: (1) perceived susceptibility (a person's subjective assessment of their risk of getting the condition, as contrasted with the statistical risk), (2) perceived severity (the seriousness of the condition and its consequences), (3) perceived barriers (both those that interfere with and facilitate the adoption of behaviour such as side effects, time, and inconvenience), and (4) perceived costs of adhering to the proposed intervention.

Empirical Studies

Oyedele (2022) examined the health consequences of environmental quality due to carbon dioxide emissions in Nigeria from 1980 to 2016. Using two health outcome measures and decomposing carbon dioxide emission by sector and type of fuel consumed, a bound cointegration approach and an autoregressive distributed lag model were also employed. The results and a sensitivity analysis revealed that aggregate carbon dioxide emission significantly explained both infant mortality and under-five mortality rates. However, when disaggregated, carbon dioxide emission from solid fuel had the greatest contribution to poor health outcomes.

Afolayan (2020) examined the joint effect of carbon emissions and health investment on economic development in Nigeria by integrating the ecological economics approach with the endogenous growth model. Through the adoption of annual time series spanning 1980-2017, the bounds testing approach of the Autoregressive Distributed Lag (ARDL) framework established the existence of co-integration among the variables in the model. The long-run estimates revealed that a 1% increase in government health investments enhances economic development (proxied by GDP per capita) by 0.008%, while a 1% increase in the level of CO2 reduces GDP per capita by 0.1%. Furthermore, evidence shows no causal link between fossil fuel consumption (FFC) and CO2, contrary to previous studies. However, unidirectional causality from health outcomes (proxied by life expectancy) to CO2 and from CO2 to electricity consumption (ELCON) is observed. Also, increased energy consumption (FFC and ELCON) directly influences GDP per capita.

Okogor (2018) investigated the effects of environmental quality on human health status in Nigeria using the Ordinary Least Square estimation techniques. The findings indicate the existence of a long-run relationship between health as measured by life expectancy and the explanatory variables included. The outcome also demonstrates that CO2 emissions, an indicator of environmental quality, significantly reduce life expectancy. More so, income and the linear combination of access to an improved water source and access to improve sanitary facilities significantly improve life expectancy. In light of the foregoing, this research recommends that it is important for the Nigerian government to strengthen environmental regulations meant to improve people's access to a better water supply and sanitary facilities along with improved income aimed at bettering health status.

Mathew (2018) examined the long-run effect of emissions of greenhouse gas (GHG) on health outcomes in Nigeria using time series data from 1985 to 2016 engaging the auto-regressive distribution lag (ARDL) econometric approach to cointegration, and it was observed that

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human activities increase GHG to the atmosphere, this is through the combustion of fossil fuels and CO2, these are two major sources of GHG emissions (GHGE). When the quantity of carbon dioxide increases in the air, more heat is stored in the atmosphere; and this comes upon human beings, thereby causing a great harmful effect on human health. The result from ARDL econometric approach to cointegration shows that a 1% increase in GHGE reduces life expectancy by 0.0422%, which is used as a proxy for health outcome; if this happens, invariably, the mortality rate will be 146.6%. Therefore, the major strategy, among others recommended in this study for controlling gaseous emissions and increasing life expectancy, is public health expenditure, as the results also show that a 1% increase in government healthcare expenditure increases life expectancy by approximately 18.10%.

Beata, Martin, and Viera (2021) examined the associations between selected GHG emissions and the health of the European Union (EU) population represented by disability-adjusted life years (DALYs). This aim was achieved using several analytical procedures (descriptive analysis, correlation analysis, cluster analysis, and panel regression analysis), which included five environmental variables (carbon dioxide (CO_2), methane (CH_4) in CO_2 equivalent, nitrous oxide (N_2O) in CO_2 equivalent, hydrofluorocarbons (HFC) in CO_2 equivalent, sulfur hexafluoride (SF_6) in CO_2 equivalent) and one health variable (DALYs). An emphasis was placed on the use of quantitative methods. The results showed that CO_2 emissions dominate among selected GHG emissions. The revealed positive link between CO_2 and DALYs indicated that a decrease in CO_2 may be associated with a decrease in DALYs. Still, it is also true that this cannot be done without reducing emissions of other combustion products. Regarding CO_2, the least positive scores were observed in Luxembourg and Estonia. Germany had the lowest score of DALYs, representing the most positive health outcome in the EU. In terms of total GHG emissions, Ireland and Luxembourg were considered to be less positive countries compared to the other analysed countries.

Stephen (2018) carried out an investigation on the impact of carbon emissions on economic growth in Nigeria. To address the problem of carbon emissions in Nigeria, this study covers a period from 1980 -2010. Secondary data was collected from the Central Bank of Nigeria (CBN), the carbon dioxide information analysis annual publication, and the international energy agency. The variables used include; gross domestic product, emissions from fossils fuel, gas fuels, liquid fuels, and solid fuels. This was subjected to the ordinary least squares method of analysis. The result reveals that carbon emissions have a negative impact on economic growth in Nigeria. Based on the above findings, it is recommended as follows that oil-producing countries like Nigeria should be compensated through the implementation of the Kyoto protocol agreement, there should be policy measures to reduce its greenhouse gas emissions and that concerted effort by both the government and oil multinational firms and the private sector must pursue these policies vigorously to bring about carbon emission-free state.

Fodhaet (2019) investigated the relationship between economic growth and environmental degradation in a small developing country, Tunisia. The study used time-series data from the period 1961-2018, with CO2 and SO2 as the environmental indicators and GDP as the economic indicator. The study results showed that there is a long-run cointegration relationship between per capita GDP and the per capita emissions of the two pollutants (CO2 and SO2), but the relationship between CO2 emissions and GDP was found to be more monotonically increasing as compared to that between SO2 and GDP. The study further tested the causal relationship between income and pollution and found that the relationship between the two in

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Tunisia is unidirectional both in the short and long run, implying that income causes environmental damage and not vice versa.

Olusanya (2020) used the ARDL model, Mean Group (MG), and the Pooled Mean Group (PMG) model to examine the environmental Kuznets Curve (EKC) hypothesis in 43 African countries pooled into three income groups from 1980–2016. The EKC hypothesis is accepted in only 21% of the sample but rejected in 70% of the countries in the total sample. This result shows that carbon emissions increase as economic growth increases in 79% of the countries, while economic growth will lead to lower carbon emissions in only a few countries (21%). The study concludes that an increase in economic growth will induce higher emissions in most African countries. These countries should take all possible policy actions, such as the massive deployment of renewable energy, carbon tax policy, and the carbon emissions trading scheme to curtain growth in carbon emissions.

Philip (2018) investigated the direction of causal relationships among emissions, energy consumption, and economic growth in Nigeria using annual time series data for the period 1970-2013. The Johansen maximum likelihood cointegration tests indicate an existence of a unique cointegrating vector, and the normalised long-run estimates show that fossil fuel enhances carbon emissions, whereas clean energy sources (electricity) mitigate the atmospheric concentration of carbon dioxide (CO2) emissions. Similarly, the Wald exogeneity Granger causality test indicates the existence of unidirectional causation running from fossil fuel to CO2 emissions and gross domestic product (GDP) per capita. Alternatively, non-fossil energy (electric power) causes a more proportionate change in GDP per capita, but our result could not establish any causal link between electric power and carbon emissions. Finally, charting a channel towards ensuring a sustainable environment and economic development involves progressive substitutability of clean energy sources for fossil consumption.

RESEARCH DESIGN AND METHODOLOGY

Research Design

This study adopted the *Ex post facto* design. This is a quasi-experimental design examining how an independent variable affects a dependent variable.

Model Specification

The guiding econometric model for this research is specified thus:

Implicitly: $HO_t = f(GHE_t, BC_t, POP_t, INF_t)$ …………………….. (3.1)

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The explicit panel econometric model is specified thus:

$$HO_t = \beta_{0t} + \beta_1 GHE_t + \beta_2 BC_t + \beta_3 POP_t + \beta_4 INF_t + \mu_{it} \ldots\ldots\ldots (3.2)$$

Where:

HO = Health Outcome

GHE = Greenhouse Emissions

BC = Biomass Consumption

POP = Population Size

INF = Inflation Rate

t = Time Period

β's = structural Parameters to be estimated

μ = Stochastic Error Term

Unit Root/Stationary Test

This was used to test whether a variable's mean value and variance varies over time. It is necessary for time series variables to avoid the problem of spurious regression. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were used for the analysis. The augmented Dickey-Fuller (ADF) test is used to test the existence of unit roots when there is autocorrelation in the series, and lagged terms of the dependent variable are included in the equation. The following three models represent pure random walk, random walk with drift and random walk with drift and trend used in Augmented Dickey-Fuller tests:

$$\Delta \psi_t = \Omega \psi_{t-1} + \sum_{i=1}^{p} \beta_i \Delta \psi_{t-1} + \varepsilon_t$$

$$\Delta \psi_t = \alpha_0 + \Omega \psi_{t-1} + \sum_{i=1}^{p} \beta_i \Delta \psi_{t-i} + \varepsilon_t$$

$$\Delta \psi_t = \alpha_0 + \Omega \Psi + \beta_2 t + \sum_{i=1}^{p} \beta_i \Delta \psi_{t-1} + \varepsilon_t \ldots\ldots\ldots 3.3$$

where: $\Omega = (\lambda - 1)$ The null hypothesis is, $H_0 : \Omega = 0$ and the alternative hypothesis is $H_a : \Omega < 0$

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Co-integration test

This will be used to test if there exists a long-run relationship between the variables under investigation. The Johansen or Engel-Granger methodology will be used. The long-run equilibrium relationship is estimated with the following equation:

$$X_t = \alpha_0 + \alpha_1 Z_t + \varepsilon_t$$

If there is cointegration, α_0 and α_1 estimates reveal "super-consistent" estimators in the OLS regression. In this estimation, fitted values of ε_t series are tested for stationarity. In this analysis, DF or ADF may be used. However, in hypothesis testing, critical values constructed by McKinnon (1991) are used. If this series is stationary, we can conclude that there is cointegration between X_t and Z_t. The fitted values ε_t may be used as the error correction term of the model.

Granger Causality Mechanism

The Granger causality model is a statistical technique that will be carried out to the direction of causality existing between the dependent variables and the specified independent variables. The model is specified thus:

$$HO = \beta + \sum_{i}^{n} \eta_i HOr_{t-i} + \sum_{i=1}^{n} \gamma_i GHE_{t-i} + \sum_{i=1}^{n} \gamma_i BC_{t-i} + \sum_{i=1}^{n} \gamma_i FFR_{t-i} + \Omega.GHE$$

$$= \phi + \sum_{i}^{n} \theta_i GHE_{t-i} + \sum_{i}^{n} \vartheta_i HO_{t-i} + \sum_{i=1}^{n} \gamma_i BC_{t-i} + \sum_{i}^{n} \eta_i POP_{t-i} + \sum_{i=1}^{n} \gamma_i FFR_{t-i} + \psi BC$$

$$= \beta + \sum_{i=1}^{n} \gamma_i BC_{t-i} + \sum_{i}^{n} \theta_i GHE_{t-i} + \sum_{i}^{n} \vartheta_i HO_{t-i} + \sum_{i}^{n} \eta_i POP_{t-i} + \sum_{i}^{n} \eta_i FFR_{t-i} + \mu POP$$

$$= \beta + \sum_{i=1}^{n} \gamma_i POP_{t-i} + \sum_{i}^{n} \theta_i GHE_{t-i} + \sum_{i}^{n} \vartheta_i HO_{t-i} + \sum_{i=1}^{n} \gamma_i BC_{t-i} + \sum_{i=1}^{n} \gamma_i FFR_{t-i} + \mu$$

$$INF = \beta + \sum_{i=1}^{n} \gamma_i FFR_{t-i} + \sum_{i}^{n} \theta_i HO_{t-i} + \sum_{i}^{n} \vartheta_i BC_{t-i} + \sum_{i=1}^{n} \gamma_i POP_{t-i} + \sum_{i=1}^{n} \gamma_i GHE_{t-i} + \mu$$

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Data and Sources

Variables	Description	Sources
HO	Health Outcomes proxied by life expectancy in years	World Bank Statistical Bulletin
GHE	Greenhouse Emissions	World Bank Statistical Bulletin
BC	Biomass Consumption	World Bank Statistical Bulletin
POP	Population Size	National Bureau of Statistics
FFR	Female Fertility Rate	World Bank Statistical Bulletin

RESULTS AND ANALYSIS

Time series data are often assumed to be non-stationary and thus, it is necessary to perform unit root test to ensure that the data are stationary. The test was employed to avoid the problem of spurious regression. Therefore, the Augmented Dickey-Fuller (ADF) unit root test was used to determine the stationarity of the data to complement each other. The decision rule based on the ADF test is that its statistic must be greater than Mackinnon's Critical Value at a 5% level of significance and in absolute terms. The results of the unit-root test are reported in Table 4.1 below.

Unit-Root Test Result

Table 1: *Unit Root Test Result*

VARIABLE	ADF STAT.	CRITICAL VAL.	ORDER
HO	-3.929316	-1.952473	I(1)
GHE	-6.306357	-1.952473	I(1)
BC	-2.975005	-2.963972	I(1)
POP	-4.639425	-1.955020	I(1)
FFR	-3.393139	-2.963972	I(1)

Source: *Author's Computation Using E-views 10.*

Table 1 clearly shows that all the variables are stationary at the first difference (I(1)). This means the variables have unit roots until the difference is in the first order.

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Cointegration Analysis (Johansen Methodology)

Cointegration Test Result

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.707823	94.84417	69.81889	0.0002
At most 1 *	0.638063	57.93230	47.85613	0.0043
At most 2	0.406420	27.44377	29.79707	0.0912
At most 3	0.316637	11.79628	15.49471	0.1670
At most 4	0.012403	0.374429	3.841466	0.5406

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: *Author's Computation Using E-views 10.*

The Johansen method of cointegration was used for the study because all the variables are stationary at first difference. The Johansen result, as displayed in table 4.2, clearly shows evidence of cointegration as the trace statistics test indicates 2 cointegrating equations as the trace statistic value is greater than that of 5% critical value (94.84417 > 69.81889) & (57.93230 > 47.85613). This entails that there exists a long-run relationship between the variables under analysis.

Optimal Lag Selection

Table 2: Optimal Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1147.544	NA	1.61e+27	76.83630	77.06983	76.91100
1	-855.4188	467.4010	3.05e+19	59.02792	60.42912	59.47617
2	-801.0120	68.91525*	5.01e+18*	57.06747*	59.63633*	57.88927*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

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The result of the optimal lag selection criteria displayed in table 2 showed that the optimal lag length for the study is lag one. This is because most of the criteria (LR, FPE, SC, AIC and HQ) suggested using lag two. The importance of selecting an optimal lag length is that it will ensure the estimation of unbiased regression output and the minimisation of residual correlation.

Vector Error Correction Mechanism (VECM) Result

Table 3

Variables	Coefficients	Std Error	t-statistic	Prob
C	0.028696	0.008852	3.241637	0.0041
D(GHE)	-0.000251	4.64E-05	-5.410869	0.0000
D(BC)	-0.002074	0.000384	-5.406385	0.0000
D(POP)	0.000633	7.99E-05	7.927706	0.0000
D(FFR)	0.130002	0.034857	-3.729556	0.0013
ECM	-0.158950	0.119717	-1.327718	0.1992

The sign of the speed of adjustment conformed to a priori expectation with a negative sign. The value yielded -0.158950. It was an indication that the speed of adjustment to shocks within a short run is approximately 15.9% but was low. That is, the ECM parameter was 0.159 with a t-statistics of 0.1992. The result indicated that greenhouse gas emissions (GHE) and biomass consumption (BC) had a negative effect on health outcomes in Nigeria, with -0.000251 and -0.002074, respectively. The result further indicated that population (POP) and female fertility rate (FFR) had a positive impact on health outcomes. A unit increase in POP brought about 0.000633 increases in health outcomes. It was also indicated that an increase in FFR brought about a 0.130002 change in health outcomes. The t-statistic and the probability values of the variables in the model showed that all the variables were significant. The value of R^2 was 0.903, indicating that up to 90.3% of the variations in health outcomes in Nigeria were explained by the exogenous variables in the model.

The F-statistic is used to measure the statistical significance of the entire regression plane. From the ECM output, the F-statistic yielded 31.26445. Since this value is greater than the absolute value of 3, it entails that the test is statistically significant at the entire regression plane.

Pairwise Granger Causality Tests

Causality test was carried out to ascertain whether a causal relationship exists between two variables of interest. The result presented in this section represents the Granger causality of the key variables of interest. The result is presented in Table 4 below:

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Table 4

Null Hypothesis:	Obs	F-Statistic	Prob.
GHE does not Granger Cause HO	30	0.62840	0.5417
HO does not Granger Cause GHE		3.29410	0.0537
BC does not Granger Cause HO	30	0.29476	0.7473
HO does not Granger Cause BC		0.27868	0.7591
POP does not Granger Cause HO	30	1.53079	0.2360
HO does not Granger Cause POP		15.8910	4.E-05
FFR does not Granger Cause HO	30	1.53425	0.2352
HO does not Granger Cause FFR		10.2589	0.0006

Source: *Author's Computation Using E-views 10.*

The result of the Pairwise Granger Causality tests showed that the health outcome Granger causes greenhouse gas emissions (GHE), the Granger causes population size (POP), and the Granger causes female fertility rate (FFR). Hence, a uni-directional causality flows from health outcomes to the aforementioned variables.

VAR Residual Normality Test

Table 5

Component	Skewness	Chi-sq	df	Prob.
1	-0.371667	0.690682	1	0.4059
2	-0.028144	0.003960	1	0.9498
3	-0.161674	0.130692	1	0.7177
4	-0.153525	0.117850	1	0.7314
5	-1.033405	5.339631	1	0.0208
Joint		6.282816	5	0.2797

Source: *Author's Computation Using E-views 10.*

From the VAR residual normality result displayed in Table 5, it can be clearly seen that the joint probability test yielded 0.2797 > 0.05. This entails the rejection of the null hypothesis, which hypothesises that the residuals are not normally distributed. We, therefore, conclude that the residuals are normally distributed.

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VAR Serial Correlation LM Tests

Table 6

Lags	LM-Stat	Prob
1	33.92032	0.1096
2	34.04602	0.1069

Probs from chi-square with 25 df.

The probability values of the lagged LM test reveal that the values (0.1096 & 0.1069) are greater than 0.5. This entails that there is no presence of serial correlation in the model for the period analysed.

Model Stability (AR Unit-Circle)

The result of the normality test, which showed the inverse root of the AR Characteristic Polynomial, was presented in Figure 1.

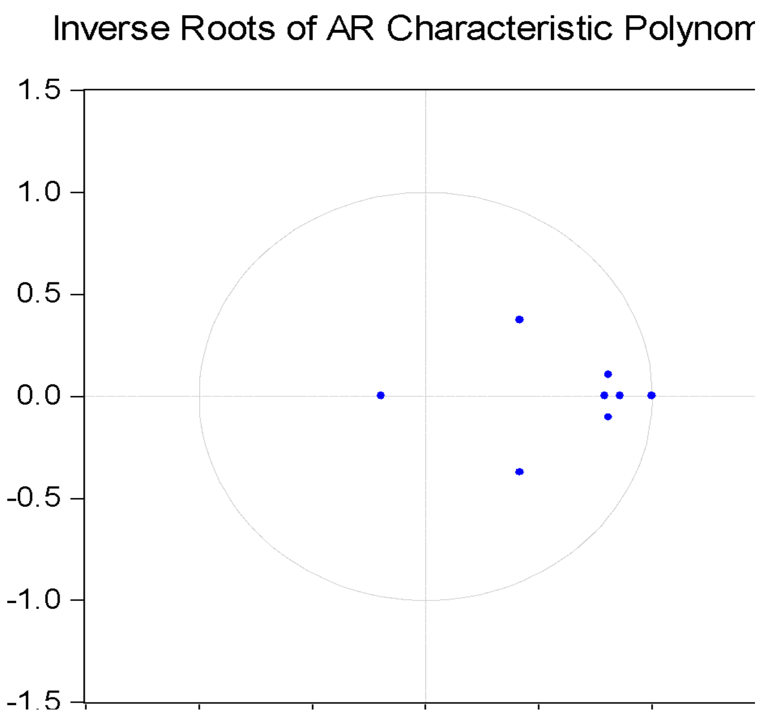

Figure 1: Model Stability Result

Source: *Researcher's Computation Using E-views 10.*

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The significance of assessing a model's stability cannot be overstated. This is done to ensure the model's dynamic stability. The only requirement for stability is that no inverse root dot is outside the unit circle. According to the AR characteristic polynomial inverse roots, the model is stable since no dot is beyond the unit circle's enclave.

SUMMARY, CONSLUSION AND RECOMMENDATION

Conclusion

This study has been able to carry out an empirical investigation on the impact of greenhouse emissions on health outcomes in Nigeria covering the period 1990 – 2021. Greenhouse gas emissions and health outcomes have attracted the attention of researchers and analysts in the literature. This, therefore, led to the decision to establish the linkage between greenhouse gas emissions and health outcomes in Nigeria. From the findings of the study, it was concluded that greenhouse gas emissions are one of the major variables that have contributed to the health deterioration of many Nigerians. Other factors negatively influence health outcomes in Nigeria, but the findings of the study throw caution on the magnitude of greenhouse gas emissions and their health deterioration effect. Having measured health outcomes with the average life expectancy in years, it was discovered that the more the rate of greenhouse gas emissions, the lower the average life expectancy in years.

Recommendations

Given the findings of this study, the following recommendations were suggested:

1. Having found out that the emissions of CO_2 impact the health of Nigerians negatively, more resources should be channelled towards research aimed at developing alternatives to greenhouse gas emissions.

2. There is a need to carry out a massive reform in our health sector. This reform should include setting up a special committee to ensure that any allocated health sector fund is adequately utilised.

3. One way to improve Nigeria's health outcomes is through reducing poverty. The federal government should engage in rural poverty alleviation projects like advancing skill acquisition programs for rural dwellers.

REFERENCES

Agbonlahor, M.U., Phillip, D.O.A. (2015). Deciding to settle: Rural-rural migration and agricultural labour supply in southwest Nigeria. *Journal of Developing Areas,* 49(4), 10-23.

Ahmeed, D.H., Naser, J., Dean, R.T. (2016), Particles impact characteristics on cutting surface during the abrasive water jet machining: Numerical study. *Journal of Materials Processing Technology,* 232, 116-130.

Article DOI: 10.52589/AJESD-FOW9ICMN
DOI URL: https://doi.org/10.52589/AJESD-FOW9ICMN

Alege, P.O., Oye, Q.E., Adu, O.O., Amu, B., Owolabi, T. (2017). Carbon emissions and the business cycle in Nigeria. International Journal of Energy Economics and Policy, 7(5), 1-8.

Al-Mulali, U., Sab, C.N.B.C., Fereidouni, H.G. (2012). Exploring the bi-directional long-run relationship between urbanisation, energy consumption, and carbon dioxide emission. Energy, 46(1), 156-167.

Anderson, J., Fergusson, M., Valsecchi, C. (2008). An overview of global greenhouse emissions and emission reduction scenarios for the future policy. Department of Economics and Science Policy. Brussels, Belgium: European Parliament.

Ansuategi, A., Escapa, M. (2002). Economic growth and greenhouse gas emissions. Ecological Economics, 40(1), 23-37.

Behera, S.R., Dash, D.P. (2017), The effect of urbanisation, energy consumption, and foreign direct investment on the carbon dioxide emission in the SSEA (South and Southeast Asian) region. Renewable and Sustainable Energy Reviews, 70, 96-106.

Botkin, D.B., Keller, E.A. (1997), Environmental Science: Earth as a Living Planet. 2nd ed. New York: John Wiley Press. p215. Cass, D. (1965), Optimum growth in an aggregative model of capital accumulation. *Review of Economic Studies*, 32, 233-240.

Declercq, W., Wirawan, E., Walle, L.V., Kersse, K., Cornelis, S., Claerhout, S., Vanoverberghe, I., Roelandt, R., De Rycke, R., Verspurten, J., and Agostinis, P. (2011). Caspase-mediated cleavage of Beclin-1 inactivates Beclin-1-induced autophagy and enhances apoptosis by promoting the release of proapoptotic factors from mitochondria. Cell death & disease, 1(1), e18.

Eckelman, D., Gregory, M. & Samuel, A. (2020). An empirical examination of the Environmental Kuznets Curve hypothesis for carbon dioxide emissions in Ghana: an ARDL approach. Environmental & Socio-Economic Studies, 4(4), 1–12. https://doi.org/10.1515/environ-2016-0019.

Ellerman, A.D., Jacoby, H.D., Decaux, F. (2009). The Effects on Developing Countries of the Kyoto Protocol and CO2 Emissions Trading. Cambridge: Joint Program on the Science and Policy of Global Change Massachusetts Institute of Technology.

Environmental Health Committee. (2004). Ambient air pollution: Health hazards to children. Paediatrics, 114(6), 1699-1707.

Jerrett, M., Eyles, J., Dufournaud, C., Birch, S., (2003). Environmental influences on health care expenditures: An exploratory analysis from Ontario, Canada. Journal of Epidemiology and Community Health, 57, 334-338.

Jiang, X.T., Li, R. (2017). Decoupling and decomposition analysis of carbon emissions from electric output in the United States. Sustainability, 9(6), 1-13

Kumar, M., Sheikh, M. A., & Saleem, S. (2014). Carbon stock in submergence forest of Srinagar hydroelectric project, Uttarakhand, India. Forest Science and Technology, 10(2), 61-66.

Koornneef, J. (2011). An empirical analysis of the relationship between CO2 emissions and economic growth in West Africa. *America Journal of Economics,* 4(1), 1-17.

Manisalidis, U. (2020). Carbon emissions and the business cycle in Nigeria. *International Journal of Energy Economics and Policy*, 7(5), 1–8.

Matthew, S., Anderson, G. & Davidson, F. (2015). Corporate social responsibility and multinational enterprise identity: insights from a mining company's attempt to localise in Ghana. Social Identities, 24(5), 604– 623. doi:10.1080/13504630.2017.1386369.

Mathew, G., Kingsley, U. & Klein, L. (2018). *Energy consumption and economic growth: evidence from 11 sub-Sahara African countries*", Energy Economics, 30(5), 2391-2400.

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DOI URL: https://doi.org/10.52589/AJESD-FOW9ICMN

Oguntoke, G. & Adeyemi, U. (2017). *CO_2 emissions, energy consumption, economic and pollution growth in Malaysia*", Renewable and Sustainable Energy Reviews, Vol. 41, pp. 594-607, doi: 10.1016/j.rser.2014.07-205.

Oguwuike, G., Anyanwu, (M. & Jideofor, L. (2019). I*nvestigating the environmental Kuznet curve hypothesis in Vietnam*", Energy Policy, 26(2) pp. 123-131, doi: 10.1016/j.exp.1.2014.11.019.

Odigure, D. (2016). Effect of economic growth on CO_2 emission in developing countries: *evidence from a dynamic panel threshold model*",

Olusanya, D. (2020). Economic Integration, Growth and the Environment in Africa: A Study of Nigeria. *Journal of Emerging Issues in Economics*, 3(2), 1274 - 1289.

Article DOI: 10.52589/AJESD-FOW9ICMN
DOI URL: https://doi.org/10.52589/AJESD-FOW9ICMN